

REMARKS

Claims 1-4 and 19 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Jeon '014 ("Jeon"). Claim 1 is independent. This rejection is respectfully traversed for the following reasons.

Claim 1, as amended, recites, "a gate insulating film having a multilayer structure including a zirconium oxide film and a high dielectric constant film which is formed of an oxide of a metal other than zirconium and substantially directly contacting the zirconium oxide film, wherein the high dielectric constant film is a hafnium oxide film, a hafnium silicate film, or a hafnium aluminate film." Support for claim 1 as amended can be found, for example, on page 10, lines 6-12 and Figure 2B of Applicants' specification.

In contrast, the alleged zirconium oxide film 110b and alleged high dielectric constant film 110c have layer 110rp interposed therebetween so as to not be substantially directly contacting each other. Indeed, Jeon discloses a gate insulating film having a multilayer structure (*see* Figs. 1 and 3-8). While the gate insulating film of the present invention is a multilayer film which can be made of only high-K films, the gate insulating film disclosed in Jeon is a multilayer film made of high-K films and standard-K films, which is clearly different from that of the present invention. According to Jeon, the high-K film includes, for example, a ZrO₂ film, and an HfO₂ film, and the standard-K film includes, for example, and SiON film and an SiN film.

The dielectric constant of the standard-K film is no more than 8, as illustrated in Table 1 of Jeon. Thus, since the gate insulating film of Jeon is a multilayer film in which the standard-K film is essential to be provided between the high-K films, as disclosed in claim 1

of Jeon, the dielectric constant of the entire gate insulating film can not increase. On the other hand, in the present invention, since the multilayer structure of the ZrO_2 film and the HfO_2 film each have a dielectric constant of no less than 10, a large dielectric constant can be obtained in the entire gate insulating film.

Moreover, although the Examiner alleges that the layer 110c of Jeon is a hafnium oxide in the rejection of claim 2 of the present invention, it is respectfully submitted that contrary to the Examiner's allegation layer 110c of Jeon is a standard-K material, not a metal oxide (high-K material) such as hafnium oxide (*see* Jeon, col. 7, lines 11-13).

For at least the reason that the gate insulating film of the present invention can have a structure that requires no standard-K film, the present invention is different from that of Jeon and is patentable over Jeon. The present invention relates to a method for manufacturing a transistor or the like using a high-K dielectric film. One of the features of the present invention resides in using a stacked structure of a ZrO_2 film and a HfO_2 film (or a hafnium silicate film of a hafnium aluminate film, hereinafter, both referred to as HfO_2 film) as the gate insulating film. In addition, the ZrO_2 film is in substantially direct contact with the HfO_2 film with no unnecessary layer being interposed therebetween.

According to the present invention, some of the effects which can be achieved include the following:

- 1) The size of the interface layer provided between the silicon substrate and the gate insulating film can be reduced as compared to the case in which only the HfO_2 film is used as the gate insulating film. Specifically, since Hf has low oxygen absorption properties, i.e., oxygen permeability, not only Hf but also silicon lying under Hf are oxidized during the oxidizing process after the deposition of Hf on the silicon substrate. As a result, the

interface layer is formed between the silicon and the HfO_2 . The interface layer is a silicon-oxide-like film of which the dielectric constant is small, and causes the dielectric constant in the entire gas insulating film to decrease. On the other hand, in the present invention, an oxide film of Zr (ZrO_2 film) having a high oxygen absorption properties, i.e., low oxygen permeability, can be provided under the HfO_2 film. Thus, the formation of the interface layer can be prevented, leading to prevent the dielectric constant of the gate insulating film from decreasing.

2) ZrO_2 has a dielectric constant higher than HfO_2 . When the multilayer structure of the ZrO_2 film and the HfO_2 film, instead of the single layer structure of the HfO_2 film, is used as the gate insulating film, the dielectric constant of the entire gate insulating film can increase, and thus EOT (equivalent oxide thickness) can be decreased.

As anticipation under 35 U.S.C. § 102 requires that each and every element of the claim be disclosed, either expressly or inherently (noting that "inherency may not be established by probabilities or possibilities", *Scaltech Inc. v. Retec/Tetra*, 178 F.3d 1378 (Fed. Cir. 1999)), in a single prior art reference, *Akzo N.V. v. U.S. Int'l Trade Commission*, 808 F.2d 1471 (Fed. Cir. 1986), based on the forgoing, it is submitted that Jeon does not anticipate claim 1, nor any claim dependent thereon.

Under Federal Circuit guidelines, a dependent claim is nonobvious if the independent claim upon which it depends is allowable because all the limitations of the independent claim are contained in the dependent claims, *Hartness International Inc. v. Simplimatic Engineering Co.*, 819 F.2d at 1100, 1108 (Fed. Cir. 1987). Accordingly, as claim 1 is patentable for the reasons set forth above, it is respectfully submitted that all claims dependent thereon are also patentable. In addition, it is respectfully submitted that the

dependent claims are patentable based on their own merits by adding novel and non-obvious features to the combination.

Based on the foregoing, it is submitted that claims 1, 3 and 4 are patentable over Jeon. Accordingly, it is respectfully requested that the rejection under 35 U.S.C. § 102 be withdrawn.

CONCLUSION

Having fully and completely responded to the Office Action, Applicants submit that all of the claims are now in condition for allowance, an indication of which is respectfully solicited. If there are any outstanding issues that might be resolved by an interview or an Examiner's amendment, the Examiner is requested to call Applicants' attorney at the telephone number shown below.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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